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Agricultural practices of the Qin people from the Warring States period to the Qin Dynasty: A case from the Matengkong site in Guanzhong Basin, China

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In archeological studies, the Qin people have often been a subject of research. The areas of investigation about the Qin include their origin, structure of tombs, funeral rites and interment processes, and cities and settlements. Although there are some studies on the Qin people's diet which were conducted through isotope analyses, research on the agricultural system of the Qin people is still limited, especially during the period from the Qin people's settlement in the Guanzhong Basin to the First Emperor bringing the seven states under his dominion. In the backdrop of the Warring States Period, it is necessary to investigate the nature of the Qin people's agricultural economy and how it impacted their social progress. This study evaluates the Qin people's agricultural practices based on flotation results from the Matengkong site, located southeast of the Guanzhong Basin in Shaanxi province. The results showed that the inhabitants practiced multi-cropping, and the crop assemblage comprised five categories, including dominant foxtail millet (*Setaria italica*) and wheat (*Triticum aestivum*), important broomcorn millet (*Panicum miliaceum*), less important soybean (*Glycine max*) and adzuki bean (*Vigna angularis*), less utilized barley (*Hordeum vulgare*), and cannabis (*Cannabis sativa*), and rice (*Oryza sativa*) of the lowest utilization. Wheat planting played a consistent and important role in agricultural production, and it appears to have had a high yield as same as foxtail millet. However, it appears to have contributed a small part of dietary intake. Rice does not appear to have been an important part of the Qin people's subsistence at the site and there is no supporting evidence that rice was grown at Matengkong. Rather, it is possible that rice might have been imported from Chu, a neighboring state to the south of Qin, through the ancient mountain passage. Adzuki bean, as a kind of crop resource, was widely used during the Zhou Dynasty. Moreover, *Chenopodium* sp. and *Vitex negundo* appear to have been intentionally used because of the high density in each single sample, but they might be multifunctional in nature.

KEYWORDS

Qin people, Eastern Zhou Dynasty, Guanzhong Basin, archaeobotany, multi-cropping, wheat, rice

Introduction

The Qin Empire played an important role in the development of Chinese civilization. Historically, the consensus has been that the Qin people replaced the Zhou to take Guanzhong Basin as their capital and environs. The Qin people gained complete victory during the end of the Warring States Period (475–221 BC), leading to the establishment of the Qin Dynasty (221–207 BC), which was the first unified multi-ethnic feudal empire of China (Sima, 1959; Wang, 2006; Liang, 2020).

The Guanzhong Basin is situated between the Qinling Mountains and Loess Plateau, ranging from Baoji in the west to Weinan in the east. It is an alluvial plain formed by the branches of the Yellow River, such as the Wei River, Jing River, and Luo River (Zhang, 2016). The landform is open and flat with fertile soil (Huang, 1988). The climate in this region is typically temperate monsoon with four distinct seasons and moderate temperatures, which has afforded the Qin rich agricultural production (Nie, 1981). However, there is a dearth of literature examining the Qin people's economics, and it is better to rely on archeological discoveries and research that often are associated with various sciences and technologies, such as archaeobotany.

Archaeobotanical research on the Guanzhong Basin has mainly focused on the Neolithic Period Sites, e.g., Zhouyuan (Zhao and Xu, 2004), Yuhuazhai (Zhao, 2017), Dongyang (Zhao, 2019), Yangguanzhai (Tang et al., 2020a), Xinglefang (Liu H. et al., 2013), Xiahe (Shang et al., 2012), Anban (Liu, 2014), and Xinjie (Zhong et al., 2015). There are a few archaeobotanical studies on the sites of the Bronze Age, such as Dongyang (Zhao, 2019), Gongbeiya (Tang et al., 2020b), and Zhouyuan (Zhao and Xu, 2004). However, these are all studies about the Zhou people's diet and agricultural practices. By analyzing the flotation results from the Matengkong site, a Qin cultural site, it is possible to study the Qin people's plant utilization, especially crop resources, after the Zhou people's emigration to the Central Plains.

Background of the Matengkong site

The Matengkong Site (109°2′12.4″E, 34°12′42.6″N) is located in the Matengkong Village, Xi'an City, in the Shaanxi Province in the southeastern region of the Guanzhong Basin. The site is on the second terrace on the west bank of the Chan River (**Figure 1**), with an area of about 3 ha; in the past, it was a small low-status settlement that represented an average farming settlement, and hence, the everyday subsistence of Qin people during this period. From 2016 to 2018, the Shaanxi Academy of Archeology excavated the site scientifically and systematically (**Figure 2**). Chronologically speaking, there are five cultural strata of the site, including the Yangshao Period, and the Eastern Zhou, and Sui, Ming, and Qing dynasties, among which cultural relics from the Eastern Zhou Dynasty (770-256 BC) are abundant, including the Spring and Autumn Period (770-476 BC) and the Warring States Period (475-221 BC) (Wang and Xu, 2019). More than 270 tombs of the Qin people from the Eastern Zhou Dynasty have been unearthed, which were located in the north of the dwelling zone (Wang and Xu, 2019).

Materials and methods

For accurate information regarding the distribution of plant remains as well as the Qin people's utilization of plants, soil samples from 2016 to 2018 were collected from the ruins, such as ash pits, dwelling floors, and kilns (Zhao, 2004, 2010). In total, 108 soil samples were collected, which have been presented in **Table 1** along with their chronological backgrounds. Because of the small sample size of the Yangshao, Spring and Autumn, and Sui and Tang periods, this study is only an analysis of the plant utilization of the Qin people from the Warring States Period to the Qin Dynasty, from which 838.6 L of soil were collected in 87 samples. The Qin Dynasty was short-lived, lasting for only 15 years (Sima, 1959), and in terms of Qin cultural relics, there is no precise method to distinguish the Warring States Period from the Qin Dynasty. Therefore, the 87 samples under examination were categorized together roughly as between the Warring States Period and Qin Dynasty.

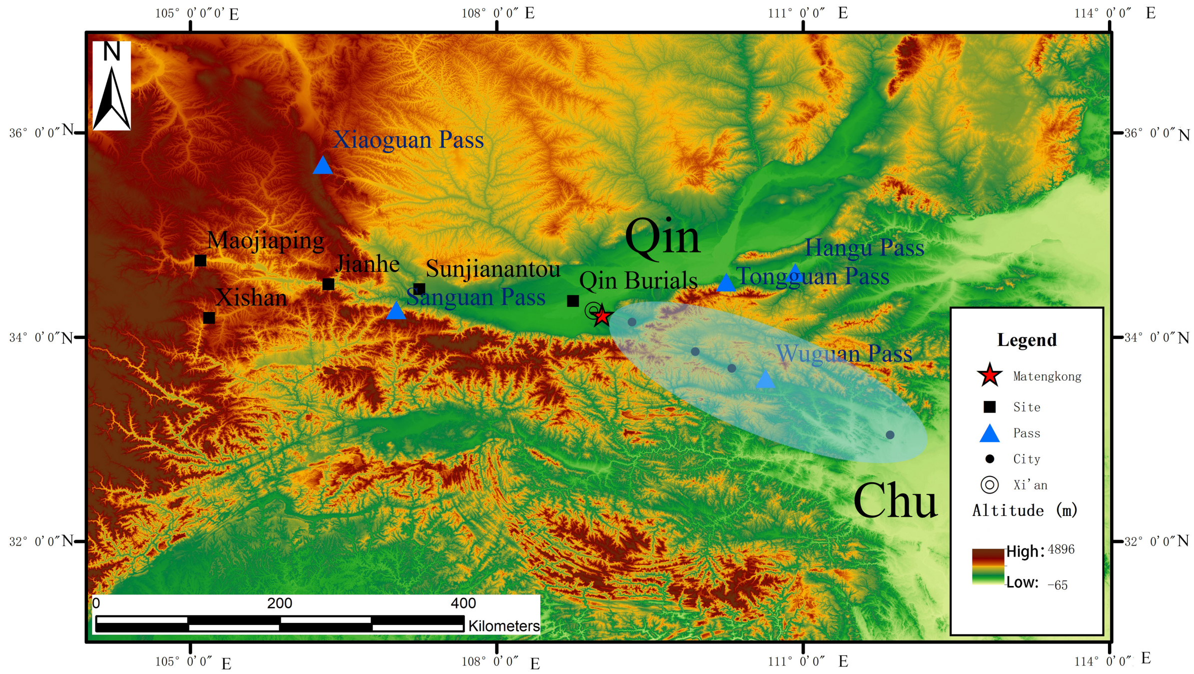

FIGURE 1
Location of Matengkong and Shang-Wu Road (The light blue shadow covers the Shang-Wu Road).

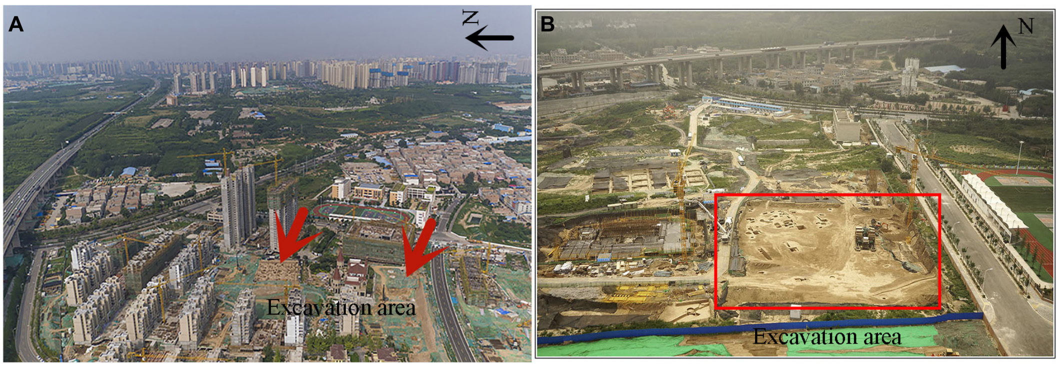

FIGURE 2
(A) Overview of the Matengkong site (red arrow showing the exact location). **(B)** On site excavation in 2016–2018 (prepared by Zhiyou Wang).

TABLE 1 The background of flotation samples from 2016 to 2018 at the Matengkong site.

Ruins	Late Yangshao period	Spring and autumn period	Warring states period to Qin dynasty	Sui and Tang dynasties	Total
Ash pit	3	2	65	9	82
Dwelling floor	5	1	10	0	18
Kiln	0	0	5	0	5
Other	0	0	7	1	3
Total	8	3	87	10	108

The plant remains were floated at the site by the wash-over bucket flotation method (Pearsall, 2000; Zhao, 2004; Fuller, 2008). Plant macro-remains were collected in sieves of the mesh size of 0.2 mm, air dried, and then further studied in the Archaeobotanical laboratory, School of Cultural Heritage, Northwestern University, for identification and analysis. The characteristics of the morphology of the plant seeds were observed and photographed under a Nikon SMZ25 stereomicroscope. The revised English version of *Flora of China* was followed for plant nomenclature.

An array of quantitative statistics are conducted, such as absolute number, percentage, ubiquity, and density of seeds. As for the procedures employed in the laboratory, we followed the guidelines enumerated in the *Paleoethnobotany: A Handbook of Procedures* (Pearsall, 2000, 2015), *Specification for the flotation work and laboratory analysis of archeological plant remains* (National Cultural Heritage Administration, 2012), and *Laboratory Procedures of Paleoethnobotany* (Zhao, 2010).

Results

In total, 48,432 carbonized plant remains were found in 87 soil samples (see the **Supplementary material** of identification results in detail), including crop remains and non-crop remains, all of which can be grouped into 38 categories, representing 19 plant families (**Supplementary Table 1**). Among them, there were 17,708 seeds of eight kinds of crops (**Figure 3**), including foxtail millet (*Setaria italica*), broomcorn millet (*Panicum miliaceum*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), rice (*Oryza sativa*), soybean (*Glycine max*), adzuki bean (*Vigna angularis*), and cannabis (*Cannabis sativa*). Foxtail millet and wheat were found to be two of the most critical crops among the crop remains, with foxtail millet being more ubiquitous than wheat. The ubiquity for foxtail millet was 100% with 15,490 grains, and that of wheat was 85.06% with 1,612 grains. The other crops were in the minority exhibiting low quantities and ubiquity. For example, broomcorn millet showed 34.48% ubiquity with 406 grains; the two kinds of legume, soybean, and adzuki bean, showed around 20% ubiquity with less than 100 grains; barley showed 13.79% ubiquity with 32 grains; cannabis showed 6.90% ubiquity with 11 grains; and finally, rice showed 3.45% ubiquity with only 10 grains.

A total of 30,724 non-crop seeds and seed fragments were identified from Matengkong (**Figure 4**), such as *Setaria* sp., Fabaceae, *Avena fatua*, *Phalaris arundinacea*, *Glycine soja*, *Vicia sepium*, *Lespedeza* sp., *Melilotus* sp., *Vitex* sp., *Vitex negundo*, *Vitex negundo* var. *heterophylla*, *Chenopodium* sp., *Salsola collina*, *Suaeda glauca*, *Kochia scoparia*, *Malva* sp., Apiaceae, *Viola* sp., *Allium tuberosum*, *Acalypha australis*, *Galium tricornutum*, *Fimbristylis* sp., *Schoenoplectus triqueter*, Polygonaceae, *Polygonum lapathifolium*, *Patrinia* sp., *Thladiantha dubia*, *Calystegia hederacea*, *Plantago asiatica*, *Vitis* sp., and *Ziziphus jujuba*. The taxonomic level of identification varied depending upon the quality of the specimen, the amount of morphological distinguishability among species in a genus, and the availability of comparative specimens for all species of that particular genus/family.

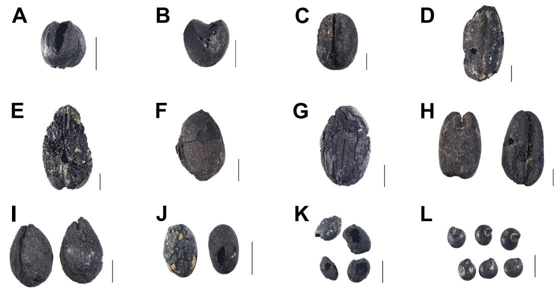

FIGURE 3
Main crop macro-remains and some larger quantities of non-crops macro-remains. **(A)** *Setaria italica*, **(B)** *Panicum miliaceum*, **(C)** *Vigna angularis*, **(D)** *Oryza sativa*, **(E)** *Hordeum vulgare*, **(F)** *Cannabis sativa*, **(G)** *Glycine max*, **(H)** *Triticum aestivum*, **(I)** *Vitex negundo*, **(J)** *Lespedeza* sp., **(K)** *Melilotus* sp., **(L)** *Chenopodium* sp. scale bars = 1 mm.

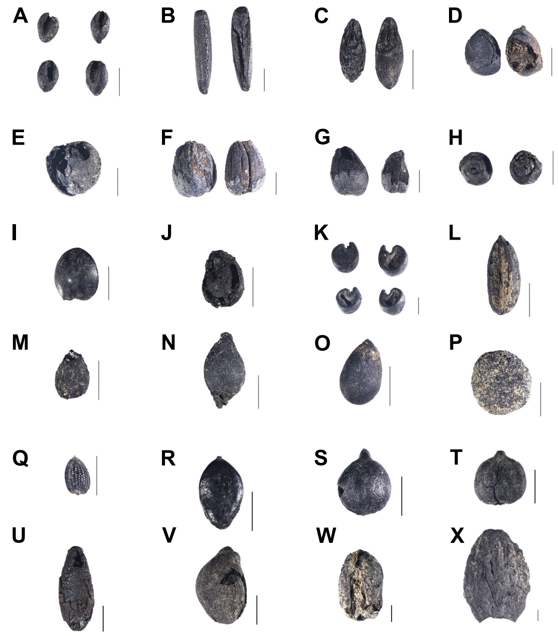

FIGURE 4
Other non-crops macro-remains in smaller quantities. **(A)** *Setaria* sp., **(B)** *Avena fatua*, **(C)** *Phalaris arundinacea*, **(D)** *Glycine soja*, **(E)** *Vicia sepium*, **(F)** *Vitex* sp., **(G)** *Vitex negundo* var. *heterophylla*, **(H)** *Salsola collina*, **(I)** *Suaeda glauca*, **(J)** *Kochia scoparia*, **(K)** *Malva* sp., **(L)** Apiaceae, **(M)** *Viola* sp., **(N)** *Allium tuberosum*, **(O)** *Acalypha australis*, **(P)** *Galium tricornutum*, **(Q)** *Fimbristylis* sp., **(R)** *Schoenoplectus triqueter*, **(S)** Polygonaceae, **(T)** *Polygonum lapathifolium*, **(U)** *Thladiantha dubia*, **(V)** *Calystegia hederacea*, **(W)** *Vitis* sp., **(X)** *Ziziphus jujuba*, scale bars = 1 mm.

TABLE 2 Crop seed quantity, percentage, and ubiquity at Matengkong from the Warring States Period to the Qin dynasty.

Taxa	Quantity	Percentage (n = 17,708)	Ubiquity (n = 87)
Setaria italica	15,490	87.47%	100%
Triticum aestivum	1,612	9.10%	85.06%
Panicum miliaceum	406	2.29%	34.48%
Glycine max	63	0.36%	21.84%
Vigna angularis	84	0.47%	19.54%
Hordeum vulgare	32	0.18%	13.79%
Cannabis sativa	11	0.06%	6.90%
Oryza sativa	10	0.06%	3.45%

Among the plant remains from the Matengkong site, the quantity and density of *Chenopodium* sp. were both unusually high. The quantity of this kind of nutlet in one sample from the ash pit H1835 was up to 26,240 contained in 19 L of soil. To avoid underestimating the roles that 79.79% of components played in the plant assemblage, the data of *Chenopodium* seeds are excluded from statistical analysis. Of course, it can certainly be inferred that *Chenopodium* sp. played an important role in ancient times, which is discussed in Section "Discussion " below.

Discussion

The characteristics of the crop assemblage at Matengkong

The crop assemblage at Matengkong from the Warring States Period to the Qin Dynasty was arranged in order of rank derived from the quantitative analysis. It shows the decreasing importance from foxtail millet and wheat to broomcorn millet, soybean and adzuki bean, barley, cannabis, and rice (**Table 2** and **Figure 5**).

Foxtail millet and broomcorn millet were typical dryland crops in northern China in ancient times, and they were characterized by their strong stress tolerance, drought resistance, barren tolerance, and salinity resistance (Yu, 2003). Wheat was the second main crop in the dryland farming system at Matengkong after foxtail millet. Legumes, including soybean and adzuki bean, provide plant-based protein and are important crops as well. Barley, cannabis, and rice account for a small percentage of crops, which means that they may have been used as some kind of supplementary crops in the multi-variety planting system. Although the cannabis seeds from the female plant are described as an edible food in *Shi Jing* 诗经 (Liu, 2017), the slender fiber was more extensively used for weaving clothes in ancient China (Zhao, 2010; Liu and Sun, 2019). Thus, few cannabis seeds were found at most of the sites in China, which can be attributed to their utilization (Liu, 2017).

The flotation results show that the inhabitants of Matengkong practiced dryland farming that largely consisted of foxtail millet and wheat. Broomcorn millet was a kind of supplementary crop. Considering the many advantages of the multivariate crop planting system, it may have motivated the Qin people's social progress. These advantages include raising the total value of agricultural output, reducing natural disasters, and increasing the diversity of crops (Zhao, 2005, 2011).

The utilization of wheat

It had been around 2,000 years since wheat was diffused into the Yellow River region from West Asia (Zhao and Fang, 2007; Wang et al., 2011; Zhouyuan Archaeological Team, 2011; Jin et al., 2013; Ma, 2017; Zhao, 2019). The use of wheat had been well documented in China's history. For example, regardless of whether the concepts were five grains 五谷, six grains 六谷, or nine grains 九谷 as recorded in Zhou Li 周礼, wheat was involved as a significant crop (Yang, 2010). Master Lv's Spring and Autumn Annals 吕氏春秋 indicated that in the first month of summer when peasants delivered new wheat, the king would taste it along with pork after offering it to the ancestral temple. In addition, in the second month of autumn, people were urged to sow wheat and not to miss the farming season. Those who failed would be punished accordingly (Tang, 2010; Yang, 2010). Therefore, it can be inferred that wheat was closely related to people's daily life in the Zhou Dynasty, and wheat cultivation was closely associated with national sacrifices and ordinances.

Wheat appears to have become increasingly important in agricultural production during the Bronze Age in China (Zhao and Fang, 2007; Wang et al., 2011; Zhouyuan Archaeological Team, 2011; Jin et al., 2013; Ma, 2017; Zhao, 2019; Deng et al., 2020; Tang et al., 2022; **Supplementary Figures 1, 2**). However, there is a contrast in the data analysis of wheat from this site. Compared with the main crop foxtail millet, the ubiquity of wheat is the second highest (**Figure 5**), whereas the percentage of the absolute quantity and density are quite low (**Figures 5, 6** and **Supplementary Table 2**).

Thousand Kernel Weight (TKW), rows per ear, ear diameter, kernels per row, and kernel percentage were found to be positively correlated with yield. Unfortunately, TKW was the only available item to roughly calculate the weight ratio of foxtail millet and wheat that were deserted at this site given that the crop remains are almost kernels (**Table 3**). The modern range of foxtail millet TKW is 1.31–3.46 g (Wu et al., 2021) and the modern range of wheat TKW is 32–40 g (Yu, 2003). **Table 3** reveals that the range of the weight ratio of the two crops available at Matengkong is 0.39–0.83, as follows:

$$P1 = \frac{(N1 \div 1000) \times 1.31}{(N2 \div 1000) \times 32} \quad P2 = \frac{(N1 \div 1000) \times 3.46}{(N2 \div 1000) \times 40}$$

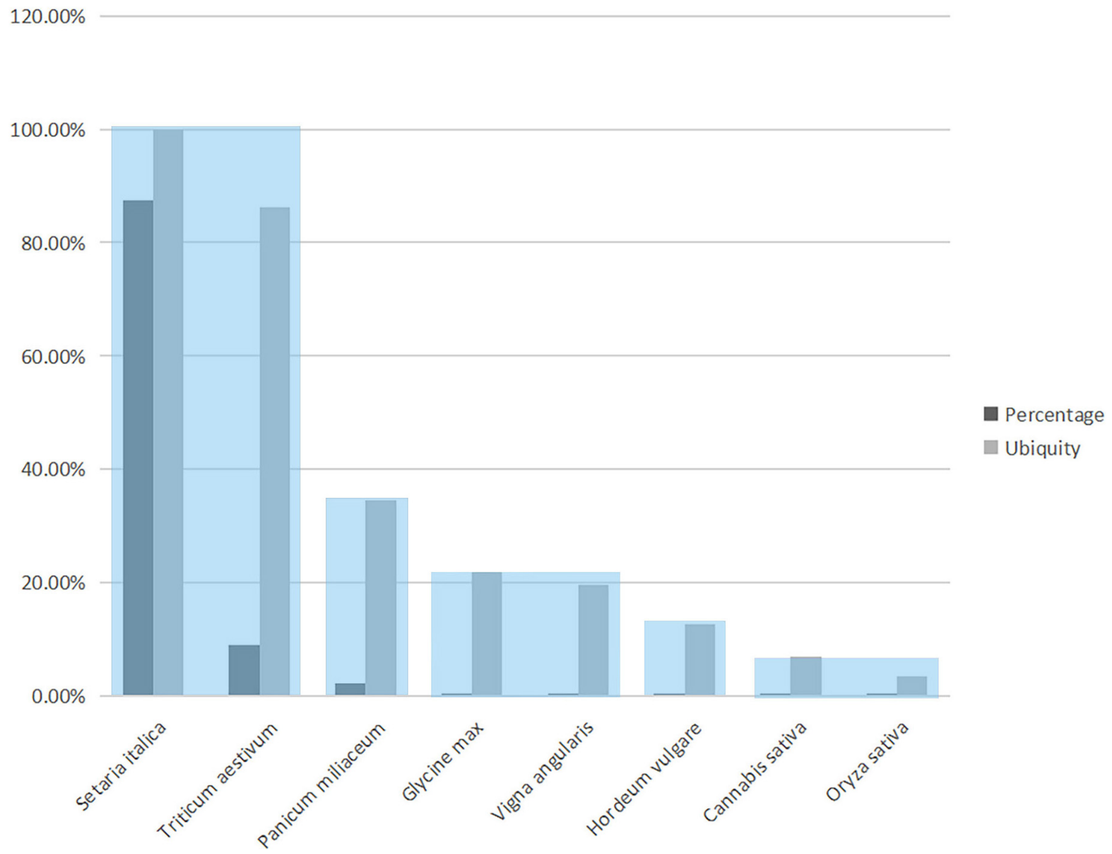

FIGURE 5
Crop percentage of absolute quantity and ubiquity at Matengkong from the Warring States Period to Qin Dynasty (*N* = 87).

where N1 = number of foxtail millet grains, N2 = number of wheat grains, P1 = Weight ratio of foxtail millet and wheat, P2 = Weight ratio of foxtail millet and wheat.

Given the condition that the bigger grains might be less easy to save at archeological sites so that wheat is supposed to be much more than its quantity available at Matengkong because it could easily be picked up by the inhabitants of Matengkong and easily uncharred than millet seeds (Jin et al., 2012; Wang et al., 2015; Zhao, 2019), the weight ratio of the two crops available at Matengkong would be much lower. In view of the range of the modern per unit yield ratio of foxtail millet and wheat is 0.43–0.63, it suggests that the wheat was cultivated by most households and its yield was as high or the same as foxtail millet.

Although wheat planting played an important role in the agricultural economy of the Qin people, it appears to have provided only a small part of their dietary intake. The $\delta^{13}C$ analysis of the skeletons of the Qin people unearthed from other nearby sites revealed that their vegetative food was reliant on C_4 plants which account for approximately 80% of it (Cai and Qiu, 1984; Zhang et al., 2003; Wei et al., 2009; Ling, 2010; Ling et al., 2010a,b, 2019; Wang et al., 2019; **Table 4** and **Supplementary Figure 4**). Hence, it would be useful for further research on the isotope analysis of the Qin people's skeletons of Matengkong to be carried out in the future.

The dynamics of rice occurrence at Matengkong

Rice originated in the middle and lower reaches of the Yangtze River in China. Given only 10 grains of rice have been found, it can be inferred that it was of little importance to the Qin people's agricultural production and their diet at the Matengkong site. The flotation results from the sites of the Zhou Dynasty also provide evidence of rice being rare in the region of the Middle Yellow River (Tang et al., 2022). Compared with this, at Xinjie, a Neolithic site in the Guanzhong Basin, plenty of rice remains, including grains and spikelet bases, were found (Zhong et al., 2015).

This situation may echo the decreasing intensity of the Holocene Asian Monsoon since 4,500 a BP (Wang et al., 2005), and the intensity of the monsoon is positively correlated with precipitation. Wang et al.'s (2005) study reveals the increasing intensity of the monsoon which had restarted from around 500

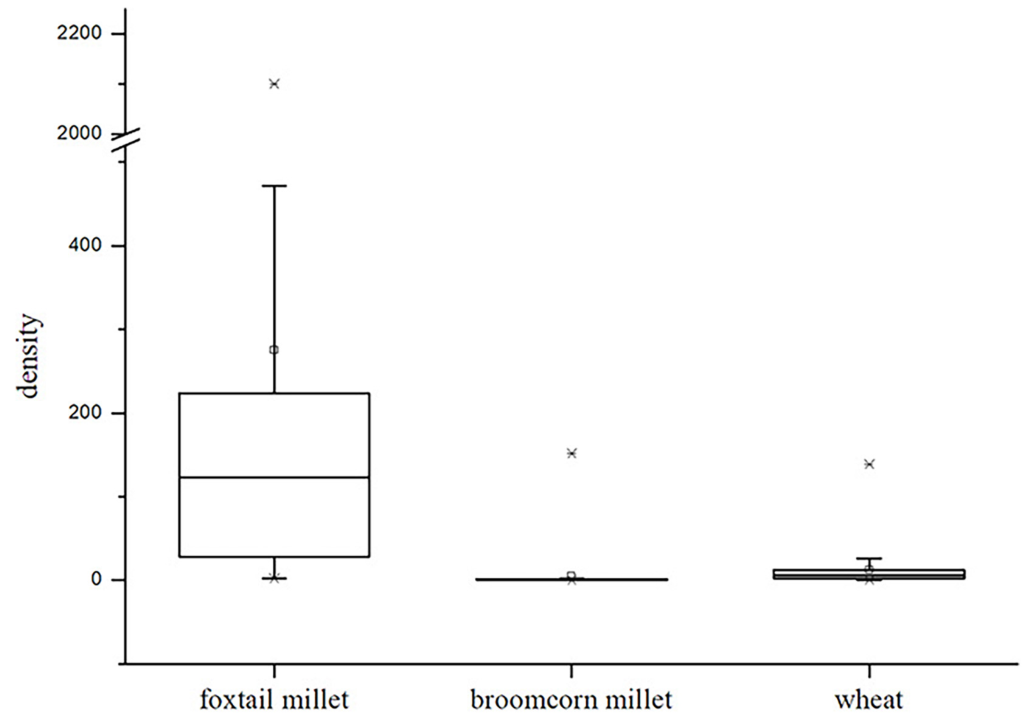

FIGURE 6
Box plots of the densities of foxtail millet, broomcorn millet and wheat from Matengkong site.

TABLE 3 The original weight of seeds and the ratio between foxtail millet and wheat at Matengkong based on their quantity and TKW.

Sequence number	Crop name	Quantity	Thousand Kernel Weight/g	Weight of crops that were deserted at Matengkong /g	Weight ratio of foxtail millet and wheat
No.1	foxtail millet	15,490 (N1)	1.31	20.29	0.39 (P1)
No.2	wheat	1,612 (N2)	32	51.58	
No.3	foxtail millet	15,490 (N1)	3.46	53.60	0.83 (P2)
No.4	wheat	1,612 (N2)	40	64.48	

a BP, and the level of recent times had almost been as high as the Yangshao Period (7,000–5,000 a BP). This situation might be supported by the fact that today there are over 50 ha of paddy fields at Wangmang Town by the northern foothills of the Qinling Mountains, only 30 km away from Matengkong (**Supplementary Figures 5**, **6**).

Within the analysis, no rice spikelet bases were recovered from the samples from Matengkong. Rice spikelet bases are one of the waste by-products from the process of de-husking, and their presence would normally indicate that the rice was grown locally (Fuller and Weber, 2005). As such, given their absence, there is no supporting evidence that rice was grown at Matengkong, and the resulting possibility is that rice might have been introduced from the Chu, a neighboring state to the south of Qin.

It is worth noting that three bronzes items (one tripod, one wine jar, and one basin) in Chu style were unearthed from Matengkong (Wang and Xu, 2019), based on which it can be inferred that there was communication between the Qin and Chu, who were located in the north and south of the huge Qinling–Dabashan Mountains, respectively. The ancient mountain passage likely played an important role in the connection between the Qin and the Chu, e.g., Shang-Wu Road (Quan, 2015; Xu and Pei, 2016) was one such mountain passage and it is still available for use (**Figure 1** and **Supplementary Figure 3**).

The utilization of adzuki bean

The quantity and ubiquity of adzuki beans from Matengkong were higher than those in other contemporary sites. Thus, such beans were certainly an important resource (CASS, 1959; Zhao, 2010; Wei et al., 2017; Wang, 2018;

TABLE 4 Human bone δ ^{13}C and δ ^{15}N values before and after the Qin people entered the Guanzhong area.

The area	Site name and the quantity of floatation samples	The relative periods of the samples	The range of δ ^{13}C value(‰)	The δ ^{13}C value on average(‰)	The range of δ ^{15}N value (‰)	The proportion of C_4 vegetative food (%)	The proportion of C_3 vegetative food (%)
Gansu Province (the northwestern place of Guanzhong Basin)	The Xishan site (Wei et al., 2009) ($n = 19$)	Late period of Mid Western Zhou to late period of Mid Warring States	−7.56 to −14.09‰	−11.42‰	7.67∼10.75‰	72%	28%
	The Maojiaping site (Wang et al., 2019) ($n = 50$)	Late Period of Western Zhou to Late Period of Warring States	−13.3 to −7.6‰	−10.41‰	8.19∼13.2‰	79.21%	20.79%
Shaanxi Province (Guanzhong Basin)	Qin tombs at Sunjianantou, Fengxiang (Ling et al., 2010b) ($n = 25$)	Mid Period of the Spring and Autumn to Mid Period of the Warring States	−8.92 to −14.62‰	−10.78‰	6.75∼9.37‰	76.57%	23.43%
	Qin tombs at Qin Burials, Xianyang (Ling et al., 2019) ($n = 26$)	The Warring States to Qin dynasty	−7.58 to −10.11‰	−9.38‰	9.43∼11.36‰	86.57%	13.43%
	Qin tombs at Jianhe, Baoji (Ling et al., 2010a) ($n = 14$)	Late Period of the Warring States	−8.19 to −10.84‰	−9.17‰	7.81∼9.39‰	88.07%	11.93%

Wei, 2018; Guo et al., 2019; Liu and Sun, 2019; Ma et al., 2019; Zhong et al., 2020). Compared with soybeans, adzuki beans are much easier to boil thoroughly, much milder in flavor, and rich in protein and vitamins (Liu and Sun, 2019); this is why it was favored by the Matengkong people.

According to studies on molecular genetics, the origin of adzuki beans domestication is polycentric; the area of origin includes China as well as Japan and the western regions of the Himalayas (Yamaguchi, 1992; Zong et al., 2003; Tao, 2017). Archeological evidence showed that the starch of *Vigna* spp. existed at the sites from the Upper Paleolithic Period to the middle Neolithic Period (Liu et al., 2010, 2014; Yang and Jiang, 2010; Liu L. et al., 2013; Chen, 2019; Sun et al., 2019). In other words, the ancient inhabitants of northern China had acquainted themselves with gathering, grinding, and eating *Vigna* spp. 10,000 years ago.

The oldest established presence of carbonized adzuki beans was found in the Liangchengzhen site in Shandong Province, where they are associated with the Longshan Culture (2,600-1,900 BC) (Crawford et al., 2005). Tao's (2017) study showed that the adzuki bean (*Vigna angularis*) had been an important crop since the period of the Shang and Zhou dynasties. However, the domestication of the bean began in China during the Longshan Period (Crawford et al., 2005; Tao, 2017). In fact, the number of sites from which adzuki beans were unearthed was obviously more during the period from the Zhou dynasty to the Han dynasty when the utilization of adzuki beans was expanded (**Figure 7** and **Supplementary Figure 7**).

There are some records of the planting of adzuki beans in the ancient Chinese agricultural literature, such as *Fan Sheng Zhi Shu* 氾胜之书 (Late Western Han Dynasty) (Wan, 1980), *Si Min Yue Ling* 四民月令 (Late Eastern Han Dynasty) (Miao, 1981), and *Qi Min Yao Shu* 齐民要术 (Northern Wei) (Miao, 1982). The archeological distribution of the adzuki bean mirrors the location of these historical documents, which includes contemporary Henan, Shanxi, and Shaanxi provinces.

The utilization of other plants

Besides crops, some other plants, such as *Chenopodium* sp. and *Vitex negundo*, appear to have been intentionally used by the Qin People because of the high density in each single sample (**Supplementary Table 1**). Both of these plants are multifunctional; however, their functions appear to be ambiguous due to the lack of multiple lines of archaeological evidence, which is a typical limitation of archeology.

Chenopodium spp. have often been unearthed at northern sites in China (Zhao, 2019). In terms of function, the stems and leaves of *Chenopodium album* are a kind of suitable fodder for

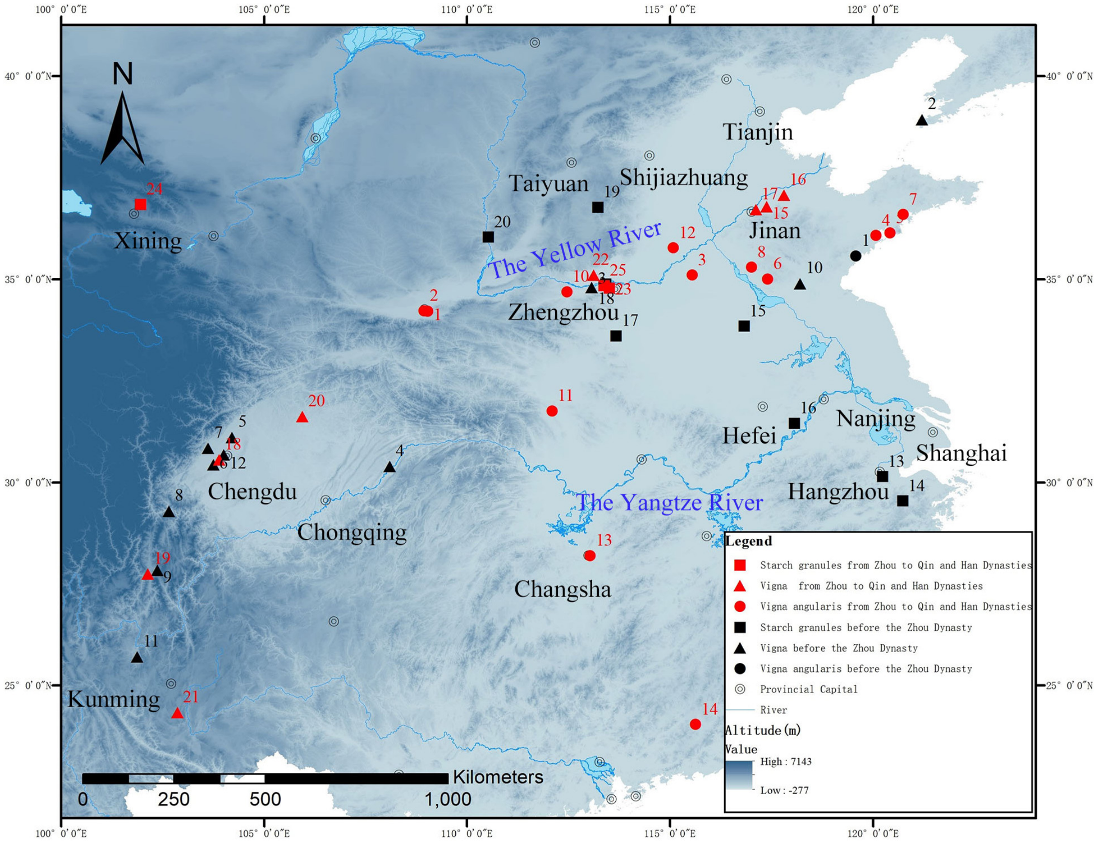

FIGURE 7
The distribution of *Vigna* and *Vigna angularis* unearthed from archeological sites in China. *Vigna angularis*, *Vigna*, Starch granules before the Zhou Dynasty: **(1)** Liangchengzhen, **(2)** Wangjiacun, **(3)** Huadizui, **(4)** Zhongba, **(5)** Guiyuanqiao, **(6)** Baodun, **(7)** Zhonghaiguoji, **(8)** Longwangmiao, **(9)** Henglanshan, **(10)** Yangguanzhuang, **(11)** Dadunzi, **(12)** Jinsha, **(13)** Kuahuqiao, **(14)** Xiaohuangshan, **(15)** Shishanzi, **(16)** Lingjiatan, **(17)** Jiahu, **(18)** Qingtai, **(19)** Niubiziwan, **(20)** Shizitan. *Vigna angularis*, *Vigna*, Starch granules from Zhou to Qin and Han Dynasties: **(1)** Matengkong, **(2)** Han Tombs of Xi-An City, **(3)** Shilipubei, **(4)** Longquanhedong, **(5)** Henanzhuang, **(6)** Beitaishang, **(7)** Beiqian, **(8)** The Ancient Capital City Site of the Zhu Kingdom, **(9)** Qingzhuangzi, **(10)** Han tombs at Shaogou Village in Luoyang, **(11)** Huanggang, **(12)** Jinqiao, **(13)** Mawangdui Tomb M1, **(14)** Shixiongshan, **(15)** Huangsangyuan, **(16)** Chenzhuang, **(17)** Daxinzhuang, **(18)** Sanguantang, **(19)** Shapingzhan, **(20)** Zhengjiaba, **(21)** Guangtoufen, **(22)** Xijincheng, **(23)** Dongzhao, **(24)** Fengtai, **(25)** Guanzhuang.

poultry (Wu et al., 2003; Qiang, 2009) as well as an edible wild herb for the Chinese people (Zhao, 2019). Although the nutlets of *Chenopodium* spp. are not an ideal food for human beings due to their small size and the hard seed coat, they can be gathered for food when the tassels are ripe (Fan, 2019). It should be noted that a similar situation with a high density of *Chenopodium* spp. also appeared at other sites (Ma et al., 2015; Zhao, 2017, 2019; Zhao and Liu, 2019; Fu et al., 2022), and there was even a report that *C. giganteum* was identified from the burial pits of the Han Yangling Mausoleum of the early Western Han Dynasty, an era following the Qin Dynasty (Yang et al., 2009), in which the function of *C. giganteum* has not been rigorously reported.

Therefore, we suggest two hypotheses for the reason a large number of *Chenopodium* sp. seeds were concentrated in one single ash pit at Matengkong. It might have been gathered for poultry fodder or it may have been used in a specific type of human food.

Neither of these hypotheses is strongly supported, and both focus on the issue of whether domestication of certain types of these plants occurred in the past, this question remains unanswered in China. First, in terms of plant taxonomy, the *Chenopodium* plants can be divided into approximately 250 species globally, among which 20 species can probably be considered to have been distributed in China (Qiang, 2009), and the seeds of *Chenopodium* plants are quite similar. Second, unlike in the United States of America (Smith and Yarnell, 2009; Fritz et al., 2017), there are no explicit standards in Chinese archeological academia for investigating *Chenopodium* domestication. Third, as mentioned above, the functions of *Chenopodium* plants are quite diverse. This calls for more archeological exploration and archaeobotany in China to better understand the functions of *Chenopodium* plants.

In addition, the density of *Vitex negundo* (2,384/10 L) from one sample was found to be very high as well. Its fiber may have been used for basket weaving (Zhang and Liang, 2009). Besides that, if the nutlets were intentionally stored, they may have been consumed as "famine food" using certain cooking methods (Fan, 2019). *Vitex negundo* has other functions, such as medical and insect repellent (Wu et al., 1994). However, it is still not clear whether people at that time had realized these alternative uses.

Conclusion

Matengkong was a small low-status settlement arising from the Qin people inhabiting the Guanzhong Basin from the Warring States Period to the Qin Dynasty. This study is an archaeobotanical analysis of the flotation results of 87 soil samples from the Matengkong site. The flotation results showed that the inhabitants practiced multi-cropping focusing on dry farming. The crop assemblage comprised five categories in descending order of importance, including dominant foxtails millet and wheat, important broomcorn millet, less important soybean and adzuki bean, less utilized barley, and lowest ubiquitous cannabis and rice. Within them, the quantity of foxtail millet and wheat together accounted for 96.58% of the crops, and their ubiquity was recorded over 85%. The low percentage of the absolute quantity of wheat and its low density are in contrast with its high ubiquity. However, in view of the TKW and the modern per unit yield ratio of foxtail millet and wheat, it suggests that wheat was a consistent element of subsistence, even if it was largely overshadowed by millets as shown in both the charred and isotopic analysis. In other words, wheat planting played an important role in the agricultural economy of the Qin people, while it appears to have provided a small part of their dietary intake. It appears that rice could not have been an important part of Qin subsistence at the site, as there is no proper evidence that Merangkong people cultivated rice locally; it originated from Qin's southern neighbor, Chu, through an ancient mountain passage. Adzuki beans were widely used as a crop resource during the Zhou Dynasty period. In addition, *Chenopodium* sp. and *Vitex negundo* appear to have been used intentionally, which can be inferred from the high density of each single sample; however, there is no definite opinion about how people used them in view of their versatility. This study compensates for the lack of archaeobotanical research on the Qin people, and of course, further flotation work and isotopic studies on the Qin people should be carried out in the future to supplement research on the Qin people.

Data availability statement

The original contributions presented in this study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding authors.

Author contributions

LT, HZ, and ZZ conceived and designed the study. LT and ZW collected the data. LT, HZ, JZ, JL, and ZG analyzed the data and wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fevo.2022.992980/full#supplementary-material

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